PROBLEM SOLVING TECHNIQUES OF PHYSICAL CHEMISTRY FOR NEET

BY

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THERMOCHEMISTRY

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BASIC EXERCISE

EXOTHERMIC/ENDOTHERMIC REACTION/THERMOCHEMICAL EQUATION

1. The formation of water from $H_2(g)$ and $O_2(g)$ is an exothermic process because :

(1) The chemical energy of $H_2(g)$ and $O_2(g)$ is more than that of water

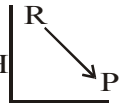
(2) The chemical energy of $H_2(g)$ and $O_2(g)$ is less than that of water

(3) The temperature of $H_2(g)$ and $O_2(g)$ is higher than that of water

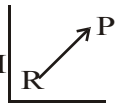
(4) The temperature of $H_2(g)$ and $O_2(g)$ is lower than that of water

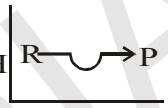
Ans. **(1)**

2. Which plot represents for an exothermic reaction:

(1) 

(2) 

(3) 

(4) 

Ans. **(1)**

3. The correct thermochemical equation is :

(1) $C + O_2 \longrightarrow CO_2 ; \Delta H = -94$ Kcal

(2) $C + O_2 \longrightarrow CO_2 ; \Delta H = +94.0$ Kcal

(3) $C(s) + O_2(g) \longrightarrow CO_2(g) ; \Delta H = -94$ Kcal

(4) $C(s) + O_2(g) \longrightarrow CO_2(g); \Delta H = +94$ Kcal

Ans. **(3)**

4. ΔH for transition of carbon in the diamond form to carbon in the graphite form is – 453.5 cal. This suggests that :

(1) Graphite is chemically different from diamond

(2) Graphite is as stable as diamond

(3) Graphite is more stable than diamond

(4) Diamond is more stable than graphite

Ans. **(3)**

5. Which of the following values of heat of formation indicates that the product is least stable

(1) – 94 K cal

(2) – 231.6 K cal

(3) + 21.4 K cal

(4) + 64.8 K cal

Ans. **(4)**

6. According to the following reaction

$C(S) + 1/2\ O_2(g) \rightarrow CO(g), \Delta H = -26.4$ Kcal

(1) CO is an endothermic compound

(2) CO is an exothermic compound

(3) The reaction is endothermic

(4) None of the above

Ans. **(2)**

7. Which of the following represents an exothermic reaction:-

(1) $N_2(g) + O_2(g) \rightarrow 2NO(g), \Delta H = 180.5$ KJ

(2) $H_2O(g) + C(s) \rightarrow CO(g) + H_2(g), \Delta E = 131.2$KJ

(3) $2HgO(s) + 180.4$ KJ $\rightarrow 2Hg(\ell) + O_2(g)$

(4) $2Zn(s) + O_2(g) \rightarrow 2ZnO(s), \Delta E = -693.8$ KJ

Ans. **(4)**

8. Consider the reaction $3O_2 \rightarrow 2O_3 ; \Delta H = +Ve$,

from the reaction, we can say that :–

(1) Ozone is more stable then oxygen

(2) Ozone is less stable then oxygen and ozone decomposes forming oxygen readily

(3) Oxygen is less stable than ozone and oxygen decomposes forming ozone readily

(4) None of the above

Ans. **(2)**

9. From the reaction P(White) $\rightarrow$ P(Red) ; ΔH = -18.4KJ, it follows that :-

(1) Red P is readily formed from white P

(2) White P is readily formed from red P

(3) White P can not be converted to red p

(4) White P can be converted into red P and red P is more sable

Ans. **(4)**

FACTORS WHICH AFFECTING ΔH OF THE REACTION

10. In Kirchoff's equation which factor affects the heat of reaction :

(1) Pressure (2) Temperature (3) Volume (4) Atomicity

Ans. **(2)**

11. For the reaction; $H_2(g) + \frac{1}{2} O_2(g) = H_2O(\ell)$, $\Delta C_p = 7.63$ cal/deg; $\Delta H_{25^0C} = 68.3$ Kcal, what will be the value (in Kcal) of ΔH at 100^0C :

(1) $7.63 \times (373 - 298) - 68.3$ (2) $7.63 \times 10^{-3} (373 - 298) - 68.3$

(3) $7.63 \times 10^{-3} (373 - 298) + 68.3$ (4) $7.63 \times (373 - 298) + 68.3$

Ans. **(3)**

12. The enthalpy of a reaction at 273 K. is – 3.57 KJ. what will be the enthalpy of reaction at 373 K if ΔC_p = zero :–

(1) – 3.57 (2) Zero (3) $-3.57 \times \frac{373}{273}$ (4) – 375

Ans. **(1)**

13. For the reactions,

(i) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g) + xKJ$ (ii) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(\ell) + yKJ$

Which one of the following statement is correct :

(1) x > y (2) x < y (3) x = y (4) More data required

Ans. **(2)**

HEAT OF FORMATION

14. Since the enthalpy of the elements in their standard states is taken to be zero. The heat of formation (ΔH_f) of compounds :

(1) Is always negative (2) Is always positive (3) Is zero (4) May be positive or negative

Ans. **(4)**

15. Reaction $H_2(g) + I_2(g) \longrightarrow 2HI$; $\Delta H = 12.40$ Kcal. According to this, heat of formation of HI will be –

(1) 12.40 Kcal (2) – 12.40 Kcal (3) – 6.20 Kcal (4) 6.20 Kcal

Ans. **(4)**

16. At 300K the satandard enthalpies of formation of $C_6H_5COOH_{(s)}$, $CO_{2(g)}$ and $H_2O_{2(l)}$ are –408, –393 and –286 kJ mol^{-1} respectively. Calculate the heat of combustion of benzoic acid at contant volume :

(1) +3201 kJ (2) +3199.75 kJ (3) –3201 kJ (4) –3199.75 kJ

Ans. **(4)**

17. Given enthalpy of formation of $CO_2(g)$ and CaO(s) are – 94.0 KJ and – 152 KJ respectively and the enthalpy of the reaction :

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$ is 42 KJ. The enthalpy of formation of $CaCO_3(s)$ is

(1) – 42 KJ (2) – 202 KJ (3) +202 KJ (4) – 288KJ

Ans. **(4)**

18. Given that standard heat enthalpy of CH_4, C_2H_4 and C_3H_8 are –17.9, 12.5, –24.8 Kcal/mol. The ΔH for $CH_4 + C_2H_4 \rightarrow C_3H_8$ is :

(1) – 55.2 Kcal (2) – 30.2 Kcal (3) 55.2 KCal (4) – 19.4 Kcal

Ans. **(4)**

19. The standard molar heat of formation of ethane, CO_2 and water(ℓ) are respectively –21.1, –94.1 and – 68.3 Kcal. The standard molar heat of combustion of ethane will be

(1) –372 Kcal (2) –162 Kcal (3) – 240 Kcal (4) –183.5 Kcal

Ans. **(1)**

20. The ΔH_f^o for $CO_{2(g)}$, $CO_{(g)}$ and $H_2O_{(g)}$ are –393.5, –110.5 and –241.8 KJ mol^{-1} respectively the standard enthalpy change (in KJ) for the reaction $CO_{2(g)}+H_{2(g)} \rightarrow CO_{(g)}+H_2O_{(g)}$ is -

(1) 524.1 (2) 41.2 (3) –262.5 (4) –41.2

Ans. **(2)**

21. The standard heat of formation of $CS_2(\ell)$ will be; given that the standard heat of combustion of carbon (s), sulphur(s) and $CS_2(\ell)$ are –393.3, –293.72 and –1108.76 KJ mol^{-1} respectively is

(1) – 128.02 KJ $mole^{-1}$ (2) + 12.802 KJ mol^{-1} (3) +128.02 KJ mol^{-1} (4) –12.802 KJ mol^{-1}

Ans. **(3)**

22. The heat of combustion of $CH_{4(g)}$, $C_{(s)}$ and $H_{2(g)}$ at 25 °C are –212.4 K cal, –94.0 K cal and –68.4 K cal respectively, the heat of formation of CH_4 will be -

(1) +54.4 K cal (2) –18.4 K cal (3) –375.2 K cal (4) +212.8 K cal

Ans. **(2)**

23. The standard heats of formation of $NO_2(g)$ and $N_2O_4(g)$ are 8.0 and 2.0 Kcal mol^{-1} respectively the heat of dimerization of NO_2 in KCal is

(1) 10.0 (2) –6.0 (3) –12.0 (4) –14.0

Ans. **(4)**

HEAT OF COMBUSTION

24. According to equation,

$C_6H_6(\ell) + 15/2\ O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(\ell)$; $\Delta H = -3264.4$ KJ mol^{-1} the energy evolved when 7.8 g benzene is burnt in air will be -

(1) 163.22 KJ (2) 32.64 KJ (3) 3.264 KJ (4) 326.4 KJ

Ans. **(4)**

25. Heat of combustion of CH_4, C_2H_6, C_2H_4 and C_2H_2 gases are –212.8, –373.0, –337.0 and –310.5 Kcal respectively at the same temperature. The best fuel among these gases is :

(1) CH_4 (2) C_2H_6 (3) C_2H_4 (4) C_2H_2

Ans. **(1)**

26. The heat of combustion of carbon and carbon monoxide are – 394 and –285 KJ mol^{-1} respectively. The heat of formation of CO in KJ mol^{-1} is:-

(1) + 109 (2) – 109 (3) + 218 (4) – 218

Ans. **(2)**

27. If heat of combustion of ethylene is 1411 KJ when a certain amount of ethylene was burnt 6226 KJ heat was evolved. Then the volume of O_2 (at NTP) that entered into the reaction is :–

(1) 296.5 ml (2) 296.5 litre (3) 6226 × 22.4 litre (4) 22.4 litre

Ans. **(2)**

28. A person requires 2870 Kcal of energy to lead normal daily life. If heat of combustion of cane sugar is –1349 Kcal, then his daily consumption of sugar is :

(1) 728 g (2) 0.728 g (3) 342 g (4) 0.342 g

Ans. **(1)**

29. On complete combustion of 2 gm methane 26575 cals heat is generated. The heat of formation of methane will be (given heat of formation of CO_2 and H_2O are – 97000 and – 68000 cals respectively) :

(1) + 20400 cals (2) + 20600 cals (3) – 20400 cals 4) – 2000 cals

Ans. **(3)**

30. X gm of ethanal was subjected to combustion in a bomb calorimeter and the heat produced is Y Joules. Then -

(1) $\Delta E_{(combustion)} = -XJ$ (2) $\Delta E_{(combustion)} = -YJ$

(3) $\Delta E_{(combustion)} = -\frac{44\,Y}{X}$ J mol^{-1} (4) $\Delta H_{(combustion)} = -\frac{44\,Y}{X}$ J mol^{-1}

Ans. **(3)**

31. The following are the heats of reactions -

(i) ΔH_f^o of $H_2O_{(\ell)} = -68.3$ K cal mol^{-1} (ii) $\Delta H_{comb.}^o$ of $C_2H_2 = -337.2$ K cal mol^{-1}

(iii) $\Delta H_{comb.}^o$ of $C_2H_4 = -363.7$ K cal mol^{-1}

Then heat change for the reaction $C_2H_2 + H_2 \rightarrow C_2H_4$ is -

(1) –716.1 K cal (2) + 337.2 K cal (3) –41.8 K cal (4) –579.5 K cal

Ans. **(3)**

32. The heat of combustion of a substance is :-

(1) Always positive (2) Always negative

(3) Numerically equal to the heat of formation (4) 1 and 3 both

Ans. **(2)**

33. The value of ΔH for the combustion of C(s) is –94.4 Kcal. The heat of formation of $CO_2(g)$ is :-

(1) –49.5 K cal (2) –94.4 K cal (3) –188.0 K cal (4) More data required

Ans. **(2)**

34. In the combustion of 0.4 g. of CH_4, 0.25 Kcal. of heat is liberated. The heat of combustion of CH_4 is

(1) – 20 K. Cals. (2) – 10 K. Cals. (3) – 2.5 K. Cals. (4) – 5 K. Cals.

Ans. **(2)**

35. If $C_6H_{12}O_6(s) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$; ΔH= - 680 Kcal The weight of $CO_2(g)$ produced when 170 Kcal of heat is evolved in the combustion of glucose is:-

(1) 265 gm (2) 66 gm (3) 11 gm (4) 64 gm

Ans. **(2)**

36. Which of the following equations corresponds to the enthalpy of combustion at 298 K :-

(1) $C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$ (2) $2C_2H_6(g) + 7\ O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$

(3) $C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$ (4) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(\ell)$

Ans. **(3)**

HEAT OF NEUTRILIZATION

37. The amount of heat liberated when one mole of NH_4OH reacts with one mole of HCl is

(1) 13.7 Kcal (2) More than 13.7 Kcal

(3) Less than 13.7 Kcal (4) Cannot be predicted

Ans. **(3)**

38. If $H^+ + OH^- = H_2O + 13.7$ Kcal, then heat of complete neutralisation of one gram mole of H_2SO_4 with strong base will be:
(1) 13.7 Kcal (2) 27.4 Kcal (3) 6.85 Kcal (4) 3.425 KCal

Ans. **(2)**

39. Heat of neutralisation of a strong dibasic acid in dilute solution by NaOH is nearly :
(1) – 27.4 Kcal/eq (2) – 13.7 Kcal / eq (3) 13.7 Kcal / eq. (4) – 13.7 Kcal/mol

Ans. **(2)**

40. The heat of neutralization of HCl by NaOH is –55.9 KJ/ mol. If the heat of neutralization of HCN by NaOH is – 12.1 KJ/mol. The energy of dissociation of HCN is
(1) – 43.8 KJ (2) 43.8 KJ (3) 68 KJ (4) – 68 KJ

Ans. **(2)**

41. The change in the enthalpy of
$NaOH + HCl \longrightarrow NaCl + H_2O$ is called :
(1) Heat of neutralisation (2) Heat of reaction (3) Heat of hydration (4) Heat of solution

Ans. **(1)**

42. Heat of neutralisation of oxalic acid is –106.7 $KJmol^{-1}$ using NaOH hence ΔH of :
$H_2C_2O_4 \longrightarrow C_2O_4^{2-} + 2H^+$ is :-
(1) 5.88 KJ (2) –5.88 KJ (3) –13.7 K cal (4) 7.5 KJ

Ans. **(4)**

HEAT OF HYDROGENATION

43. The heat of combustion of C_2H_4, C_2H_6 and H_2 are –1409.5 KJ, –1558.3 KJ and –285.6 KJ. The heat of hydrogenation of ethene is -
(1) –136.8 KJ (2) –13.68 KJ (3) 273.6 KJ (4) 1.368 KJ

Ans. **(1)**

44. The enthalpy of combustion of cyclohexane, cyclohexene and H_2 are respectively - 3920, - 3800 and - 241 KJ mol^{-1}. The heat of hydrogenation of cyclohexene is:-
(1) –121 KJ mol^{-1} (2) 121 KJ mol^{-1} (3) –242 KJ mol^{-1} (4) 242 KJ mol^{-1}

Ans. **(1)**

BOND ENERGY/RESONANCE ENERGY

45. Bond energy of a molecule :
(1) Is always negative (2) Is always positive
(3) Either positive or negative (4) Depends upon the physical state of the system

Ans. **(2)**

46. Among the following for which reaction heat of reaction represents bond energy of HCl
(1) $HCl(g) \longrightarrow H^+(g) + Cl^-(g)$ (2) $HCl(g) \longrightarrow \frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g)$
(3) $2HCl(g) \longrightarrow H_2(g) + Cl_2(g)$ (4) $HCl(g) \longrightarrow H(g) + Cl(g)$

Ans. **(4)**

47. The bond energies of F_2, Cl_2, Br_2 and I_2 are 155.4, 243.6, 193.2 and 151.2 $KJmol^{-1}$ respectively. The strongest bond is :
(1) F – F (2) Cl – Cl (3) Br – Br (4) I – I

Ans. **(2)**

48. Heat evolved in the reaction $H_2 + Cl_2 \longrightarrow 2HCl$ is 182 KJ. Bond energies of H–H and Cl–Cl are 430 and 242 KJ/ mol respectively. The H – Cl bond energy is :
(1) 245 KJ mol^{-1} (2) 427 KJ mol^{-1} (3) 336 KJ mol^{-1} (4) 154 KJ mol^{-1}

Ans. **(2)**

49. The enthalpy change for the reaction

$H_2(g) + C_2H_4(g) \rightarrow C_2H_6(g)$ is..... . The bond energies are,

$H-H = 103, C-H = 99, C-C = 80$ &

$C=C = 145$ K cal mol^{-1}

(1) –10 K cal mol^{-1} (2) +10 K cal mol^{-1} (3) – 30 K cal mol^{-1} (4) +30 K cal mol^{-1}

Ans. **(3)**

50. Bond dissociation enthalphies of $H_2(g)$ and $N_2(g)$ are 436.0 kJ mol^{-1} and 941.8 kJ mol^{-1} respectively and enthalpy of formation of $NH_3(g)$ is –46 kJ mol^{-1}. What is enthalpy of atomization of $NH_3(g)$?

(1) 390.3 kJ mol^{-1} (2) 1170.9 kJ mol^{-1} (3) 590 kJ mol^{-1} (4) 720 kJ mol^{-1}

Ans. **(2)**

51. From the reactions :

$C(s) + 2H_2(g) \rightarrow CH_4(g)\ \Delta H = -X$ Kcal

$C(g) + 4H(g) \rightarrow CH_4(g),\ \Delta H = -X_1$ Kcal

$CH_4(g) \rightarrow CH_3(g) + H(g)\ \Delta H = +Y$(Kcal)

Bond energy of C–H bond is –

(1) $\frac{X}{4}$ K cal. mol^{-1} (2) Y K cal. mol^{-1} (3) $\frac{X_1}{4}$ K cal. mol^{-1} (4) X_1 K cal. mol^{-1}

Ans. **(3)**

52. The enthalpy changes at 298 K in successive breaking of O–H bonds of water are

$H_2O \longrightarrow H(g) + OH(g);\ \Delta H = 498$ KJ mol^{-1}

$OH(g) \longrightarrow H(g) + O(g)\ ;\ \Delta H = 428$ KJmol^{-1}

the bond enthalpy of O–H bond is

(1) 498 KJ mol^{-1} (2) 428 KJ mol^{-1} (3) 70 KJ mol^{-1} (4) 463 KJ mol^{-1}

Ans. **(4)**

53. Heat of dissociation of benzene to elements is 5535 KJ mol^{-1}. The bond enthalpies of C – C, C = C and C – H are 347.3, 615.0 and 416.2 KJ respectively. Resonance energy of benzene is

(1) 1.51 KJ (2) 15.1 KJ (3) 151 KJ (4) 1511 KJ

Ans. **(3)**

SOME OTHER HEAT OF REACTIONS

54. The enthalpy change for the reaction

$2C(\text{graphite}) + 3H_2(g) \longrightarrow C_2H_6(g)$ is called

(1) Enthalpy of formation (2) Enthalpy of combustion

(3) Enthalpy of hydrogenation (4) Enthalpy of vaporisation

Ans. **(1)**

55. The magnitude of heat of solution ..... on addition of solvent to solution

(1) Decreases (2) Increases (3) Remains constant (4) Increases or decreases

Ans. **(3)**

56. If $H_2(g) = 2H(g)\ ;\ \Delta H = 104$ Kcal, than heat of atomisation of hydrogen is :

(1) 52 Kcal (2) 104 Kcal (3) 208 Kcal (4) None of these

Ans. **(2)**

57. For the change C (diamond) $\longrightarrow$ C(graphite) ; $\Delta H = -1.89$ KJ, if 6 g of diamond and 6g of graphite are seperately burnt to yield CO_2 the heat liberated in first case is :

(1) Less than in the second case by 1.89 KJ (2) Less than in the second case by 11.34 KJ

(3) Less than in the second case by 14.34KJ (4) More than in the second case by 0.945KJ

Ans. **(2)**

58. $2CO_{(g)} + O_{2(g)} \longrightarrow 2CO_{2(g)} + X$ KJ

In the above equation X KJ refers to :

(1) Heat of formation of CO_2 (2) Heat of vapourisation

(3) Heat of reaction (4) Heat of sublimation

Ans. **(2)**

59. Which of the following reactions represents ΔH (hydration) :–

(1) $CuSO_4(s) + (aq) \rightarrow CuSO_4(aq)$; $\Delta H = -xKJ$

(2) $BaCl_2(s) + 2H_2O(\ell) \rightarrow BaCl_2 . 2H_2O(s)$; $\Delta H = -x'$ KJ

(3) $CuSO_4(s) + 5H_2O(\ell) + (aq) \rightarrow CuSO_4 . 5H_2O(aq)$; $\Delta H = -y'$ KJ

(4) None of the above

Ans. **(2)**

60. ΔH for the reaction, $I_{(g)} + I_{(g)} \rightarrow I_2(g)$ will be:-

(1) Zero (2) – ve (3) + ve (4) ∞

Ans. **(2)**

61. Given that :

$A(s) \rightarrow A(\ell)$; $\Delta H = x$, $A(\ell) \rightarrow A(g) - y$

The heat of sublimation of A will be:-

(1) x + y (2) x - y (3) x or y (4) - (x + y)

Ans. **(2)**

HESS'S LAW

62. The enthalpy change of a reaction does not depend on

(1) State of reactants and products (2) Nature of reactants and products

(3) Different intermediate reactions (4) Initial and final enthalpy change of reaction

Ans. **(2)**

63. From the thermochemical reactions,

C(graphite) + ½ $O_2 \longrightarrow$ CO ; $\Delta H = -110.5$ KJ

CO + ½ $O_2 \longrightarrow$ CO_2 ; $\Delta H = -283.2$ KJ

the heat of reaction of C(graphite) + $O_2 \longrightarrow$ CO_2 is :

(1) 393.7 KJ (2) – 393.7 KJ (3) – 172.7 KJ (4) + 172.7 KJ

Ans. **(2)**

64. If $H_2 + ½\ O_2 \longrightarrow H_2O$; $\Delta H = -68.39$ Kcal

$K + H_2O$ + water $\longrightarrow$ KOH(aq) + ½ H_2 ; $\Delta H = -48.0$ Kcal

KOH + water $\longrightarrow$ KOH (aq) $\Delta H = -14.0$ Kcal the heat of formation of KOH is -

(1) – 68.39 + 48 – 14.0 (2) – 68.39 – 48.0 + 14.0

(3) +68.39 – 48.0 + 14.0 (4) + 68.39 + 48.0 – 14.0

Ans. **(2)**

65. From the following data, the heat of formation of $Ca(OH)_2(s)$ at 18^0C is ..... Kcal.

(i) $CaO(s) + H_2O(\ell) = Ca(OH)_2(s)$;

$\Delta H_{18^0C} = -15.26$ Kcal.....

(ii) $H_2O(\ell) = H_2(g) + ½\ O_2(g)$;

$\Delta H_{18^0C} = 68.37$ Kcal ...

(iii) $Ca(s) + ½\ O_2(g) = CaO(s)$;

$\Delta H_{18^0C} = -151.80$ Kcal .....

(1) – 98.69 (2) – 235.43 (3) 194.91 (4) 98.69

Ans. **(2)**

66. (i) $S(s) + 3/2\ O_2(g) = SO_3(g) + 2x$ Kcal

(ii) $SO_2(g)\ ½\ O_2(g) = SO_3(g) + y$ Kcal find out the heat of formation of SO_2 :

(1) (2x + y) (2) –(2x – y) (3) x + y (4) 2x / y

Ans. **(2)**

67. Given that -

$2C(s) + 2O_2(g) \rightarrow 2CO_2(g)$ $\Delta H = -787$ KJ

$H_2(g) + ½\ O_2(g) \rightarrow H_2O(\ell)$ $\Delta H = -286$ KJ

$C_2H_2(g) + \frac{5}{2} O_2(g) \rightarrow 2CO_2(g) + H_2O(\ell) \Delta H = -1310$ KJ

Heat of formation of acetylene is :-

(1) + 1802 KJ (2) – 1802 KJ (3) – 800 KJ (4) + 237 KJ

Ans. **(4)**

68. Find the heat change in the reaction : $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

from the following data

$NH_3(g) + aq \rightarrow NH_3(aq)$, $\Delta H = -8.4$ K. Cal.

$HCl(g) + aq \rightarrow HCl(aq)$, $\Delta H = -17.3$ K. Cal.

$NH_3(aq) + HCl(aq) \rightarrow NH_4Cl(aq), \Delta H = -12.5$ K. Cals.

$NH_4Cl(s) + aq \rightarrow NH_4Cl(aq)$, $\Delta H = +3.9$ K.Cal.

(1) – 42.1 (2) – 34.3 (3) + 34.3 (4) + 42.1

Ans. **(1)**

69. $C(s) + O_2(g) \rightarrow CO_2(g) + 94.0$ K cal.

$CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$, $\Delta H = -67.7$ K cal.

from the above reactions find how much heat (Kcal $mole^{-1}$) would be produced in the following reaction:

$C(s) + \frac{1}{2} O_2(g) \rightarrow CO(g)$

(1) 20.6 (2) 26.3 (3) 44.2 (4) 161.6

Ans. **(2)**

70. $H_2(g) + ½\ O_2(g) = H_2O(\ell)$; $\Delta H_{298K} = -68.32$Kcal. Heat of vapourisation of water at 1 atm and 25°C is 10.52 Kcal. The standard heat of formation (in Kcal) of 1 mole of water vapour at 25°C is

(1) 10.52 (2) –78.84 (3) +57.80 (4) –57.80

Ans. **(4)**

71. One mole of anhydrous salt AB dissolves in water and librates 21.0 J mol^{-1} of heat. The value of $\Delta H_{(hydration)}$ of AB is –29.4 J mol^{-1}. The heat of dissolution of hydrated salt $AB.2H_2O_{(s)}$ is -

(1) 50.4 J mol^{-1} (2) 8.4 J mol^{-1} (3) –50.4 J mol^{-1} (5) –8.4 J mol^{-1}

Ans. **(2)**

72. Which of the following expressions is true:-

(1) $H_f^0\ (CO,g) = \frac{1}{2}\ \Delta H_f^0\ (CO_2,g)$ (2) $\Delta H_f^0\ (CO,g) = \Delta H_f^0\ (C,graphite) + \frac{1}{2}\ \Delta H_f^0(O_2,g)$

(3) $\Delta H_f^0\ (CO,g) = \Delta H_f^0\ (CO_2,g) - \frac{1}{2}\ \Delta H_f^0\ (O_2,g)$ (4) $\Delta H_f^0\ (CO,g) = \Delta H_{comb}^0\ (C,graphite) - \Delta H_{comb}^0\ (CO,g)$

Ans. **(4)**

ANALYTICAL EXERCISE

1. $\Delta S°$ will be highest for the reaction

(1) $Ca + \frac{1}{2}O_2(g) \rightarrow CaO(s)$ (2) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

(3) $C(s) + O_2(g) \rightarrow CO_2(g)$ (4) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

Ans. **(2)**

2. In an irreversible process, the value of $\Delta S_{system} + \Delta S_{surr}$ is

(1) +ve (2) -ve (3) Zero (4) All of these

Ans. **(1)**

3. The enthalpy and entropy change for a chemical reaction are -2.5×10^3 cal and 7.4 cal K^{-1} respectively. Predict the nature of reaction at 298 K is

(1) Spontaneous (2) Reversible (3) Irreversible (4) Non-spontaneous

Ans. **(1)**

4. The standard heat of formation of $NO_2(g)$ and $N_2O_4(g)$ are 8.0 and 4.0 kcal mol^{-1} respectively. The heat of dimerisation of NO_2 in kcal is

(1) -12 kcal (2) 12 kcal (3) 4 kcal (4) 16 kcal

Ans. **(1)**

5. If $\frac{1}{2}X_2O(s) \rightarrow X(s) + \frac{1}{4}O_2(g)$; $\Delta H = 90$ kJ.

Then heat change during reaction of metal X with one mole of O_2 to form oxide to maximum extent is

(1) 360 kJ (2) –360 kJ (3) –180 kJ (4) +180 kJ

Ans. **(2)**

6. For a gaseous reaction $A(g) + 3B(g) \rightarrow 3C(g) + 3D(g)$

ΔE is 17 kcal at 27°C. Assuming $R = 2$ cal K^{-1} mol^{-1} the value of ΔH for the above reaction will be

(1) 15.8 kcal (2) 16.4 kcal (3) 18.2 kcal (4) 20.0 kcal

Ans. **(3)**

7. Enthalpy of formation of NH_3 is –X kJ and ΔH_{H-H}, ΔH_{N-H} are respectively Y kJ mol^{-1} and Z kJ mol^{-1}. The value of $\Delta H_{N\equiv N}$ is

(1) $Y - 6Z + \frac{X}{3}$ (2) $-3Y + 6Z - 2X$ (3) $3Y + 6Z + X$ (4) $Y + 6X + Z$

Ans. **(2)**

8. The heat of neutralisation for strong acid and strong base forming 2 moles of water is

(1) -2×57.1 kJ (2) –57.1 kJ

(3) $-\frac{57.1}{2}$ kJ (4) Strong acid and strong base will not go neutralisation

Ans. **(1)**

9. The value of $\Delta H°$ in kJ for the reaction will be

$CS_2(l) + 4NOCl(g) \rightarrow CCl_4(l) + 2SO_2(g) + 2N_2(g)$ if

$\Delta H_f^o(CS_2) = -x$ $\Delta H_f^o(NOCl) = -y$

$\Delta H_f^o(CCl_4) = +z$ $\Delta H_f^o(SO_2) = -r$

(1) x + 4y – z – 2r (2) r + z + 4y – x (3) 2r + z + 4y + x (4) x + 4y + z – 2r

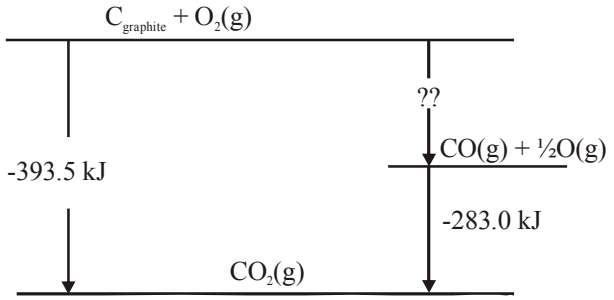
Ans. **(4)**

10. The heat liberated on complete combustion of 1 mole of CH_4 gas to $CO_2(g)$ and $H_2O(l)$ is 890 kJ. Calculate the heat evolved by 2.4 L of CH_4 on complete combustion.

(1) 95.3 kJ (2) 8900 kJ (3) 890 kJ (4) 8.9 kJ

Ans. **(1)**

11. A schematic representation of enthalpy changes for the reaction, $C_{(graphite)} + \frac{1}{2}O_2(g) \rightarrow CO\ (g)$ is given below. The missing value is



(1) +10.5 kJ (2) –11.05 kJ (3) –110.5 kJ (4) –10.5 kJ

Ans. **(3)**

12. Which of the following equations represent standard heat of formation of CH_4 ?

(1) $C_{(diamond)} + 2H_2(g) \rightarrow CH_4\ (g)$ (2) $C_{(graphite)} + 2H_2(g) \rightarrow CH_4\ (g)$

(3) $C_{(diamond)} + 4H(g) \rightarrow CH_4\ (g)$ (4) $C_{(graphite)} + 4H(g) \rightarrow CH_4\ (g)$

Ans. **(2)**

13. Calorific value of ethane, in kJ/g for the reaction

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$; $\Delta H = -745.6$ kcal

(1) –12.4 (2) –52 (3) –24.8 (4) –104

Ans. **(2)**

14. If the bond dissociation energies of XY, X_2 and Y_2 (all diatomic molecules) are in the ratio of 1 : 1 : 0.5 and Δ_fH for the formation of XY is –200 kJ mol^{-1}. The bond dissociation energy of X_2 will be :-

(1) 200 kJ mol^{-1} (2) 100 kJ mol^{-1} (3) 800 kJ mol^{-1} (4) 300 kJ mol^{-1}

Ans. **(3)**

15. The standard enthlapy of formation ($\Delta_fH°$) at 298K for methane, $CH_4(g)$, is –74.8 kJ mol^{-1}. The additional information required to determine the average energy for C–H bond formation would be:-

(1) Latent heat of vapourization of methane

(2) The first four ionization energies of carbon and electron gain enthalpy of hydrogen

(3) The dissociation energy of hydrogen molecule H_2

(4) The dissociation energy of H_2 and enthalpy of sublimation of carbon

Ans. **(4)**

16. The enthalpy changes for the following processes are listed below :

$Cl_2(g) = 2Cl(g)$, 242.3 kJ mol^{-1}

$I_2(g) = 2I(g)$, 151.0 kJ mol^{-1}

$ICl(g) = I(g) + Cl(g)$, 211.3 kJ mol^{-1}

$I_2(s) = I_2(g)$, 62.76 kJ mol^{-1}

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for ICl(g) is :-

(1) –16.8 kJ mol^{-1} (2) +16.8 kJ mol^{-1} (3) +244.8 kJ mol^{-1} (4) –14.6 kJ mol^{-1}

Ans. **(2)**

17. In conversion of lime-stone to lime, $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

the values of $\Delta H°$ and $\Delta S°$ are +179.1 kJ mol^{-1} and 160.2 J/K respectively at 298 K and 1 bar. Assuming that $\Delta H°$ and $\Delta S°$ do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is :-

(1) 1008 K (2) 1200 K (3) 845 K (4) 1118 K

Ans. **(3)**

18. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mol of water is vapourised at 1 bar pressure and 100°C, (Given : Molar enthalpy of vapourisation of water at 1 bar and 373 K = 41 kJ mol^{-1} and R = 8.3 J mol^{-1} K^{-1} will be) :-

(1) 4.100 kJ mol^{-1} (2) 3.7904 kJ mol^{-1} (3) 37.904 kJ mol^{-1} (4) 41.00 kJ mol^{-1}

Ans. **(3)**

19. Identify the correct statement regarding a spontaneous process :-

(1) For a spontaneous process in an isolated system,the change in entropy is positive

(2) Endothermic processes are never spontaneous

(3) Exothermic processes are always spontaneous

(4) Lowering of energy in the reaction process is the only criterion for spontaneity

Ans. **(3)**

20. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:

$$\frac{1}{2}Cl_2(g) \xrightarrow{\frac{1}{2}\Delta_{diss}H\ominus} Cl(g) \xrightarrow{\Delta_{eg}H\ominus} Cl^-(g) \xrightarrow{\Delta_{hyd}H\ominus} Cl^-(aq)$$

The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$

(using the data $\Delta_{diss}\ H^{\ominus}_{Cl_2} = 240$ kJ mol^{-1}, $\Delta_{eg}\ H^{\ominus}_{Cl} = -349$ kJ mol^{-1}, $\Delta_{hyd}\ H^{\ominus}_{Cl^-} = -381$ kJ mol^{-1}) will be:-

(1) –610 kJ mol^{-1} (2) –850 kJ mol^{-1} (3) +120 kJ mol^{-1} (4) +152 kJ mol^{-1}

Ans. **(3)**

21. On the basis of the following thermochemical data : $\left(\Delta H^0_f H^+_{(aq)} = 0\right)$

$H_2O(\ell) \rightarrow H^+(aq) + OH^-(aq)$; $\Delta H = 57.32$ kJ

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$; $\Delta H = -286.20$ kJ

The value of enthalpy of formation of OH^- ion at 25°C is :-

(1) +228.88 kJ (2) –343.52 kJ (3) –22.88 kJ (4) –228.88 kJ

Ans. **(3)**

22. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$$CH_3OH(\ell) + \frac{3}{2}O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$$

At 298 K standard Gibb's energies of formation for $CH_3OH(\ell)$, $H_2O(\ell)$ and $CO_2(g)$ are –166.2, –237.2 and –394.4 kJmol^{-1} respectively. If standard enthalpy of combustion of methanol is –726 kJ mol^{-1}, efficiency of the fuel cell will be

(1) 90% (2) 97% (3) 80% (4) 87%

Ans. **(2)**

23. The standard enthalpy of formation of NH_3 is –46.0 kJ mol^{-1}. If the enthalpy of formation of H_2 from its atoms is –436 kJ mol^{-1} and that of N_2 is –712kJ mol^{-1}, the average bond enthalpy of N–H bond in NH_3 is :-

(1) –1102 kJ mol^{-1} (2) –964 kJ mol^{-1} (3) + 352 kJ mol^{-1} (4) +1056 kJ mol^{-1}

Ans. **(3)**

24. The value of enthalpy change (ΔH) for the reaction

$C_2H_5OH_{(\ell)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(\ell)}$

at 27°C is –1366.5 kJ mol^{-1}. The value of internal energy change for the above reaction at this temperature will be:-

(1) –1371.5 kJ (2) –1369.0 kJ (3) –1364.0 kJ (4) –1361.5 kJ

Ans. **(3)**

25. Consider the reaction :

$4NO_{2(g)} + O_{2(g)} \rightarrow 2N_2O_{5(s)}$, $\Delta_rH = -111$kJ.

If $N_2O_{5(s)}$ is formed instead of $N_2O_{5(g)}$ in the above reaction, the Δ_rH value will be :-

(given, ΔH of sublimation for N_2O_5 is 54 kJ mol^{-1})

(1) –165 kJ (2) +54 kJ (3) +219 kJ (4) –219 kJ

Ans. **(4)**

ASSERTION & REASON EXERCISE

These questions consist of two statements each, printed as *Assertion* and *Reason.* While answering these Questions you are required to choose any one of the following four responses.

A. **If both *Assertion* & *Reason* are True & the *Reason* is a correct explanation of the *Assertion*.**

B. **If both *Assertion* & *Reason* are True but *Reason* is not a correct explanation of the Assertion.**

C. **If *Assertion* is True but the *Reason* is False.**

D. **If both *Assertion* & *Reason* are False.**

1. ***Assertion* :–** The enthalpies of neutralisation of strong acids and strong bases are always same.

***Reason* :–** neutralization is heat of formation of water.

Ans. **(C)**

2. ***Assertion* :–** Heat of neutralization of perchloric acid, $HClO_4$ with NaOH is same as is that of HCl with NaOH.

***Reason* :–** Both HCl and $HClO_4$ are strong acids.

Ans. **(A)**

3. ***Assertion* :–** For the combustion of methane, $\Delta E > \Delta H$

***Reason* :–** ΔH is released by ΔE by expression. $\Delta H = \Delta E + \Delta nRT$

Ans. **(C)**

4. ***Assertion* :–** Heat of neutralization for HF is –68.552 kJ/eq. where as for HCl it is –57.26 kJ/eq.

***Reason* :–** The acid of HF is weak acid.

Ans. **(D)**

5. ***Assertion* :–** In a diatomic molecule involving two like atoms covalently bonded with each other, bond energy = 2 × heat of formation of atom.

***Reason* :–** $H \longrightarrow 2H$; $e_{H-H} = \Delta H$

Ans. **(C)**

6. ***Assertion* :–** Bond energy for breaking up a bond is endothermic.

***Reason* :–** Heat is required to overpower the attractions between two atoms.

Ans. **(C)**

7. ***Assertion* :–** Heat of combustion are always exothermic.

***Reason* :–** Combustion of N_2 to give NO is exothermic.

Ans. **(A)**

8. ***Assertion* :–** Standard heat enthalpy of a compound is its heat of formation at 25°C and 1 atm.

***Reason* :–** Standard heat enthalpy of pure elements have arbitrarily assumed to be zero.

Ans. **(C)**

9. ***Assertion* :–** The variation of heat of reaction with temperature are given in terms of Kirchhoff's equation.

***Reason* :–** The Kirchhoff's equation is : $\Delta H = \Delta U + \Delta nRT$

Ans. **(A)**

10. ***Assertion* :–** Heat of neutralization can be given as :

$$H^+ + OH^- \longrightarrow H_2O \ ; \ \Delta H = -13.6 \text{ kcal}$$

***Reason* :–** Heat of neutralization can be alternatively defined as heat of formation of water.

Ans. **(A)**

11. ***Assertion :–*** The dissolution of NaCl in water is endothermic, though it is spontaneous process.

Reason :– ΔG for the process is –ve because ΔH_{sol} is very low and thus $T\Delta S > \Delta H$.

Ans. **(C)**

12. ***Assertion :–*** Heat of combustion of C_2H_6 is –341.1 kcal mol^{-1} and heat of combustion of C_2H_2 is –310 kcal mol^{-1} but C_2H_2 is better fuel.

Reason :– The better fuel has high calorific value.

Ans. **(C)**

13. ***Assertion :–*** There is no reaction known for which ΔG is positive, yet it is spontaneous.

Reason :– For photochemical reactions, ΔG is negative.

Ans. **(D)**

14. ***Assertion :–*** Enthalpy of graphite is lower than that of diamond.

Reason :– Entropy of graphite is greater than that of diamond.

Ans. **(B)**

15. ***Assertion :–*** For a particular reaction, heat of combustion at constant pressure (q_p) is always greater than that at constant volume (q_v).

Reason :– Combustion reactions are invariably accomplished by increase in no. of moles.

Ans. **(D)**